WATER QUALITY AND QUANTITY SURVEY

AREA NORTH OF LIVELY

SOUTH OF CREIGHTON MINE

TOWN OF WALDEN

Ministry of the Environment
Ontario

The Honourable
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Minister

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Deputy Minister

KWOC

Water Quality - Ontario.

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1978

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INTRODUCTION

On June 9, 1978, at the meeting of the Regional Municipality of Sudbury and Ministry of the Environment Liaison Committee, a request for a project under the Private Water and Sewage Grants scheme was presented for the area north of Lively (Town of Walden). In order to assess the need for private funding, a survey was requested to acquire a priority rating. If the area surveyed indicated more problems than anticipated, communal servicing would then need to be considered.

From August 21, 1978 to October 12, 1978, 36 of the 46 (78%) residences were surveyed, including one commercial establishment. The population of the area is approximately 123. Three of the 46 residences within the survey area are serviced by communal water supply from the Community of Lively (Appendix A and D).

Location and Study Limits

The study area is located approximately 1.4 km north of Lively and 1.3 km south of Creighton Mine on Regional Road 24 in the Town of Walden. This area was formerly known as Waters Township (N 1/2 Lot 8, Conc. 6) and encompasses the residential subdivisons west of Regional Road 24 and north of the old Creighton Mine Road on Regional Road 24. One commercial establishment, a garage, is located on Regional Road 24.

The following table lists the streets on which residences were surveyed. In order to allow comparisons and to detect problems by area , two subareas were created within the study to facilitate the investigations (Appendix A).

AREA	STREET
A	Regional Road 24
B	John Street, Michael Street, Selma Street, David Street, Arnold Street, Elaine Street, Suzanne Street, Matilda Street.

It should be noted that the three properties serviced by communal water from Lively are located within area "A".

Physical Description & Topography

The study area lies entirely on the igneous rock of the Cambrian Shield. Due to erosion and glacial activity, the rock outcroppings are bare and polished while depressions are filled with glacial drift.

A relatively large swamp area exists to the southwest with rock outcroppings predominating throughout the rest of the study area. Regional Road 24 provides a barrier between the study area and Meatbird Lake to the east. The study area is approximately six feet below the grade of Regional Road 24.

The Inco Vermilion River water supply line which in part services the Community of Lively, runs parallel to Regional Road 24, approximately 50 feet north of the road and the study area.

Surface drainage flows from the rock outcroppings in the northwest, down to the highway and then to the swamp area in the southwest. This drainage then empties into a small unnamed lake to the southwest of the study area.

Both areas A and B consist of undulating slopes covered with small amounts of glacial till. The low areas consist of gravel and clay deposits.

In general, the rock outcroppings and clay subsoil conditions prevent proper drainage throughout the area.

SURVEY PROCEDURES

A survey form was completed at each residence by interviewing the owner or tenant. Appendix B is a sample of this form. The lot was plotted to show the location of the house, well and sewage disposal system. During the plotting, checks for malfunctioning sewage systems or direct discharges were undertaken.

A bacteriological and chemical drinking water sample was collected at each residence. Bacteriological samples were forwarded to the Ministry of Health Laboratory in Sudbury for coliform bacteria examination. Chemical samples were shipped to the Ministry of the Environment Laboratory in Toronto and analyzed for colour, turbidity, iron, alkalinity, hardness, chloride, sulphate, pH, nitrate, sodium, manganese and conductivity.

Forty-six residences were in the survey area. Five residences were vacant, two residences did not want to be surveyed and no answers were received from three residences following numerous attempted contacts.

QUESTIONNAIRE RESULTS

Sewage Disposal

Appendix C summarizes the types and ages of the sewage disposal systems reported by the owners or tenants.

Of the 36 systems inspected, 32 (88%) were septic tanks with tile fields, 2 were pit privies, and two consisted of a leaching pit and holding tank.

System ages ranged from 1 year to greater than 40 years. The majority of systems appear to be in the range of three to fifteen years with the ages of ten systems not determined.

Lot inspections and interviews revealed 7 (19%) systems with existing problems. Two systems were allowing the direct discharge of wash water into the ditches. The other 5 were experiencing problems with their field beds.

Water Supplies

Of the 36 residences sampled, 3 were serviced by communal water supply from Lively. The remaining 33 supplies consisted of 28 dug wells (85%), 4 drilled wells (12%) and 1 point type well along with 2 residences sharing 1 dug well.

Approximately 24% of all the wells were between 3 and 15 years old with the remaining being greater than 15 years. The age of 6 wells (18%) were not determined.

When interviewed, 10 (27%) residents complained of taste problems, 5 (14%) complained of odour problems, 9 (25%) complained of colour, 18 (50%) experienced problems with iron, 13 (36%) complained of hardness problems and 18 (50%) experienced quantity problems during the summer dry periods. An interesting observation was made by the residents who stated that they experienced quantity problems, in their wells when the level of Meatbird Lake varied. One resident complained of the water line freezing during the winter.

Treatment is used in 4 of the homes, 3 of which utilize filters to correct the iron problem.

SAMPLE RESULTS

Water Supplies

Bacteriological Results

Results of the bacteriological analysis of drinking water supplies indicated 13 (39%) samples were contaminated by the total coliform group while 6 (18%) samples contained both a total and a faecal coliform count. The presence of total coliforms may indicate soil runoff or possibly less recent sewage pollution. Faecal coliforms originate in the intestinal tract of warm-blooded animals and their presence in well water supplies strongly suggests nearby and recent pollution.

Of the 13 samples containing total and faecal coliforms, all were received from dug well water supplies (Appendix D).

Bacteriological contamination was relatively extensive and the shallow aquifer servicing the entire study area could possibly be considered contaminated from a bacteriological standpoint.

Chemical Results

Nitrate levels may affect formula fed infants under 3 months of age in concentrations greater than 10 mg/L. This level was exceeded in 8 (25%) of the samples of the survey area.

Elevated nitrate levels were associated with dug wells, with 1 exception, which was a drilled well (Appendix E).

When an analysis of a water supply indicated nitrates exceeding the guidelines, the owner and the Medical Officer of Health were immediately notified by letter informing the users of the potential risk to newborn infants, although no cases of nitrate induced methemoglobinemia have been reported in the Sudbury area. Nitrates present no risks to consumers over 3 months of age.

Sodium, a constituent of common salt, may aggravate hypertension and complicate heart disease. People placed on salt diets should limit their consumption of this material. This pertains to the mineral in solid form or mixed with water in drinking supplies. Although no official criteria exists, the Ministry of the Environment had adopted the interim procedure of notifying the Medical Officer of Health of any water supplies with sodium in excess of 20 mg/L.

Water softening equipment used by many households, exchanges sodium for the objectionable calcium salts, and removes hardness associated with these salts. Since water samples were collected after such equipment, homes with softeners were not considered to represent actual groundwater conditions. Omitting these, 26 (79%) of the drinking water samples exceeded 20 mg/L. A list of the residences with elevated sodium was forwarded to the Medical Officer of Health for evaluation and follow-up procedures.

Iron and manganese stain and discolour laundry and plumbing fixtures when present in concentrations greater than 0.3 mg/L and 0.05 mg/L respectively. They are considered a nuisance and not a health hazard. Iron and manganese exceeded the criteria in an average of 48% and 91% respectively, of the water supplies throughout the entire area.

Colour and turbidity levels (frequently associated with iron and manganese) also affect the appearance of a water supply but do not constitute a health hazard. For the entire area, 70% and 73% respectively of the samples contained colour and turbidity levels in excess of the guidelines.

In general, the aquifer contains nitrate, iron, manganese, colour and turbidity, in excess to the permissible criteria of the Ministry of the Environment guide for drinking water objectives.

CONCLUSIONS

The groundwater aquifers, shallow and possibly deep, presently providing sources of water supply for the residents of the study area, north of Lively, are highly coloured and turbid, and contain excessive levels of iron, manganese, and sodium. Such water can be considered to be aesthetically displeasing and with the widespread bacteriological and chemical hazards, can be considered unsatisfactory for a drinking water supply.

Nitrate levels observed in the study area were high enough to be of concern, although excessive levels were largely restricted to shallow dug wells.

All the sewage system problems observed during the survey can be rectified on an individual basis and do not represent a serious health or environmental problem.

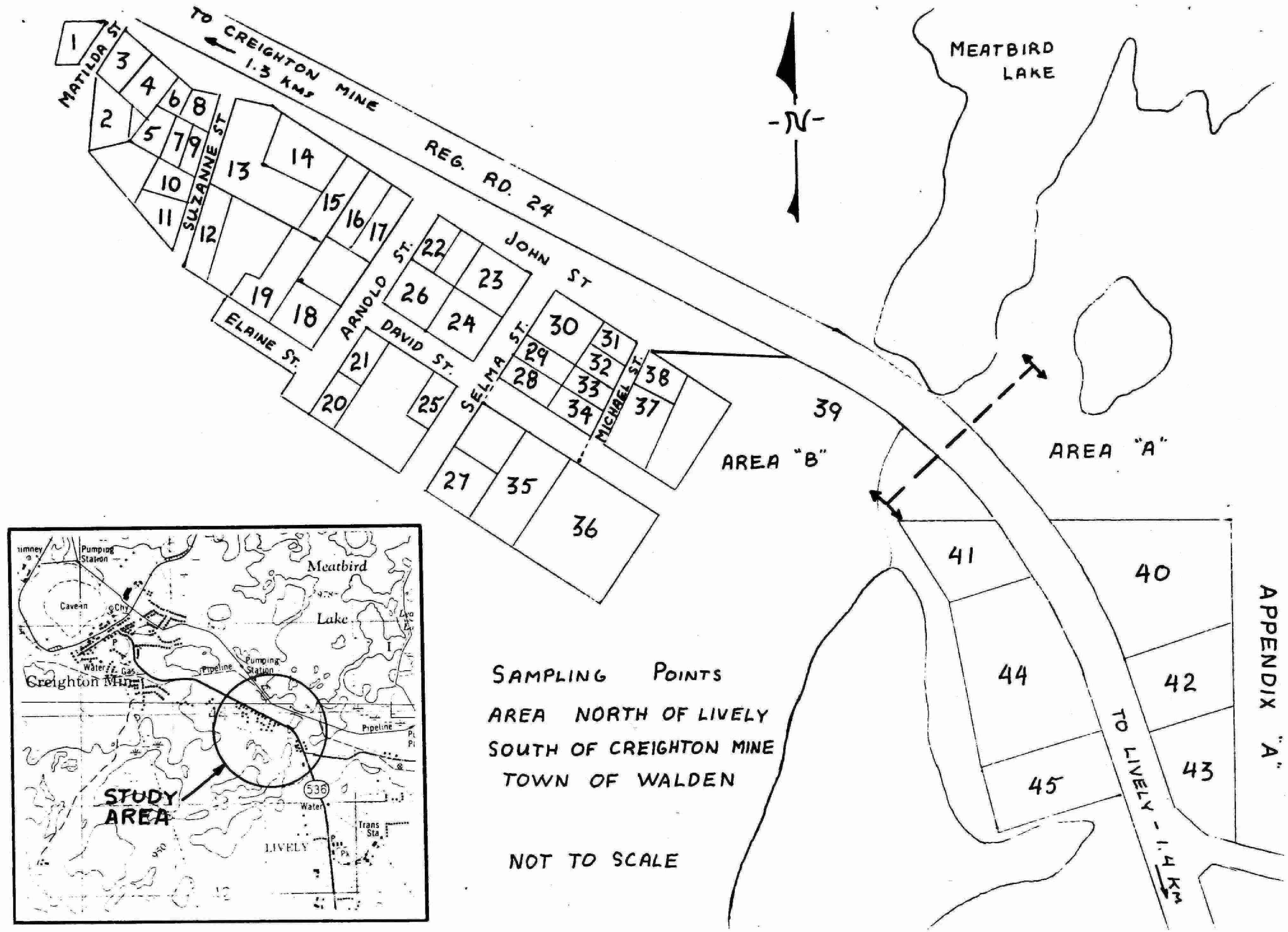
Water shortages were reported as a somewhat serious problem by the residents of the study area during dry periods of the year.

RECOMMENDATIONS

Based upon the levels of nitrates, sodium and coliform bacteria found in the groundwater, along with nuisance levels of iron, manganese, colour and turbidity, a communal water service should be considered for this area.

Cost comparison calculations have been made in order to estimate the most viable solution (Appendix F). Alternative "B" communal water supply is recommended due to the close proximity of the Inco Water Supply Line and the guarantee of adequate potable water along with the assurance of adequate water for fire protection.

APPENDIX "A"



SAMPLING POINTS
AREA NORTH OF LIVELY
SOUTH OF CREIGHTON MINE
TOWN OF WALDEN
NOT TO SCALE
TO CREIGHTON MINE 1.3 KMS
REG. RD. 24
TO LIVELY - 1.4 KM
MEATBIRD LAKE
AREA "A"
AREA "B"
N
MATILDA ST
SUZANNE ST
ELAINE ST.
ARNOLD ST.
DAVID ST.
JOHN ST
SELMA ST.
MICHAEL ST.
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Meatbird Lake
Creighton Mine
Pumping Station
Cave-in
Pipeline
Water
Gas
536
LIVELY
Trans Sta.
STUDY AREA

SURVEY FORM

APPENDIX "B"

COMMUNITY: ______

INFORMATION RECEIVED FROM: ______

SURVEYED BY: ______

SAMPLE INFORMATION

Type	Bacteriological		Chemical		
Sample No.					
Sample Location					
Results	Total	Faecal	Total	Faecal	

PROPERTY INFORMATION

Name of Owner ______ Owner's Phone No. ______

Permanent Address ______

Name of Resident ______

Lot No.	Conc.No.	Township	Community	Street Address	Phone No.

Size of Lot	Drainage	Topography	Soil Type

No. of Residents	No. of Bedrooms	Laundry Facilities	Other

SEWAGE DISPOSAL SYSTEM

Type	Septic Tank ____ Tile Bed ____ (enter distances)	Leaching Pit	Pit Privy	Other (Specify)

Age	Distance to Surface Water	Distance to Water Supply	

Comments: ______

Note Quantity

WATER SUPPLY

Type	Surface Water	Dug Well	Drilled Well	Cased Well	Point

Depth	Age	Type & Capacity of Pressure System	Type of Pipe	Chlorinator	Filtration

Comments:	Taste	Odour	Colour	Iron	Hardness	Quantity	Quality	

DIAGRAM ON REVERSE SIDE SHOWING LOCATION AND DISTANCES FOR WATER SUPPLY AND SEWAGE DISPOSAL

Appendix C

Questionnaire Results - Sewage Systems

House No.	Name	Type of Sewage System	Age (years)	Distance to Well (feet)	Operating Ability
1	M. Wasney	Septic tank/tile bed	>40	>100	Functioning Properly
2	A. Green	Pit Privy	?	100	Grey Water Discharge
3	D. Nesbitts	Septic tank/tile bed	10	>50	Functioning Properly
4	D. Filippo	Septic tank/tile bed	16	50	Functioning Properly
5	L. Bissonnette	Pit Privy	10	150	Grey Water Discharge
6	Vacant				
7	Vacant				
8	D. Clapcott	Holding tank/leaching pit	15	40	Functioning Properly
9	Vacant				
10	J. Wdovic	Holding tank	1½	50	Functioning Properly
11	B. Leipala	Septic tank/tile bed	?	?	Functioning Properly
12	W. Ranta	Septic tank/tile bed	20	100	Functioning Properly
13	D. Young	Septic tank/tile bed	5	200	Functioning Properly
14	H. Sikala	Septic tank/leaching pit	20	100	Sewage Odour
15	K. McParland	Septic tank/tile bed	7	50	Functioning Properly
16	R. Menard	Septic tank/tile bed	3	60	Sewage Odour
17	L. Johnson	Septic tank/tile bed	3	50	Functioning Properly
18	R. Richard	Septic tank/tile bed	6	45	Tile bed Leaking
19	F. Dawson	Septic tank/tile bed	3	?	Functioning Properly
20	P. Lahtinen	Septic tank/tile bed	19	60	Functioning Properly

21	A. Lehman	Septic tank/leaching pit	?	20	Functioning Properly
22	P. Elson	Septic tank/tile bed	3	40	Functioning Properly
23	A. Dejneta	Septic tank/tile bed	20	50	Functioning Properly
24	A. Marcinishym	Septic tank/tile bed	23	20	Functioning Properly
25	Did not want to be surveyed				
26	R. Dawson	Septic tank/tile bed	9	90	Functioning Properly
27	No answer at door when surveyed.				
28	S. Evans	Septic tank/tile bed	10	30	Functioning Properly
29	J. Labelle	Septic tank/tile bed	?	?	Functioning Properly
30	Vacant				
31	E. Smith	Septic tank/tile bed	1	25	Functioning Properly
32	J. Neva	Septic tank/tile bed	?	20	Functioning Properly
33	K. Rahnenfuehrer	Septic tank/tile bed	28	10	Functioning Properly
34	E. Ranta	Septic tank/tile bed	19	55	Tile bed Leaking
35	T. Grosart	Septic tank/tile bed	17	65	Functioning Properly
36	L. Farrell	Septic tank/tile bed	17	50	Functioning Properly
37	Vacant				
38	J. Sikala	Septic tank/tile bed	>10	38	Functioning Properly
39	No answer at door when surveyed				
40	K. Radey	Septic tank/tile bed	20	communal water	Sewage system Blocked
41	No answer at door when surveyed				
42	P. Kirkbride	Septic tank/tile bed	6	communal water	Functioning Properly

43	A. Kresam	Septic tank/tile bed	13	150	Functioning Properly
44	D. Crowder	Septic tank/tile bed	?	communal water	Functioning Properly
45	B. Patchett	Septic tank/tile bed	?	>50	Functioning Properly
46	Did not want to be surveyed.				

Appendix D

Bacteriological Results

House No.	Name	Type of Well	Age (years)	Depth (feet)	Coliform Total	Coliform Faecal
1	M. Wasney	Dug	23	20	86	1
2	A. Green	Dug	20	22	<2	0
3	D. Nesbitts	Dug	?	?	<2	0
4	D. Filippo	Dug	22	12	36	0
5	L. Bissonnette	Dug	25	20	156	2
6	Vacant					
7	Vacant					
8	D. Clapcott	Dug	15	?	4	0
9	Vacant					
10	J. Wdovic	No sample taken - house vacant.				
11	B. Leipala	Dug	?	?	<2	0
12	W. Ranta	Dug	33	20	<2	0
13	D. Young	Dug	30	20	<2	0
14	H. Sikala	Point	10	68	<2	0
15	K. McParland	Dug	20	?	<2	0
16	R. Menard	Drilled	11	47	<2	0
17	L. Johnson	Drilled	3	75	<2	0
18	R. Richard	Dug	12	?	<2	0
19	F. Dawson	Dug	14	20	<2	0
20	P. Lahtinen	Dug	19	?	<2	0
21	A. Lehman	Dug	30	?	>160	2
22	P. Elson	Dug	30	15	<2	0
23	A. Dejneta	Dug	20	12	136	0
24	A. Marcinishym	Dug	23	9	<2	0
25	Did not want to be surveyed					

26	R. Dawson	Dug	30	11	92	0
27	No answer at door when surveyed.					
28	S. Evans	Dug	38	10	<2	0
29	J. Labelle	Dug	?	?	<2	0
30	Vacant					
31	E. Smith	Dug	20	6	16	0
32	J. Neva	Dug	?	?	14	0
33	K. Rahnenfuehrer	Dug	28	?	20	12
34	E. Ranta	Drilled	14	125	<2	0
35	T. Grosart	Drilled	?	138	<2	0
36	L. Farrell	Dug	20	15	10	1
37	Vacant					
38	J. Sikala	Dug	720	?	<2	0
39	No answer at door when surveyed					
40	K. Radey		Serviced by communal water			
41	No answer at door when surveyed					
42	P. Kirkbride		Serviced by communal water			
43	A. Kresam	Dug	18	12	6	3
44	D. Crowder (Garage)		Serviced by communal water			
45	B. Patchett	Dug	?	?	34	0
46	Did not want to be surveyed.					

CHEMICAL RESULTS

House No.	Name	Colour H.U.	Tur.* F.T.U.	Hard.* mg/L	Alk* mg/L	Iron mg/L	Cl* mg/L	pH	Conduc.* umhos/l	Sulphate mg/L	Nitrate mg/L	Man* mg/L	Sodium mg/L	Potassium mg/L
1	M. Wasney	16	7.0	290	11	1.1	880	6.0	2850	89	0.8	0.37	510	7.9
2	A. Green	11	2.4	130	33	0.16	40	6.4	355	82	0.3	0.113	15	4.6
3	D. Nesbitts	9.7	1.6	154	17	0.31	178	6.1	675	62	0.9	0.066	69	4.0
4	D. Filippo	3.1	0.43	134	16	<0.5	100	5.9	540	68	5.2	0.074	51	4.8
5	L.Bissonnette	19	5.8	166	51	1.0	115	5.8	650	89	1.9	0.69	63	16.0
6	Vacant													
7	Vacant													
8	D. Clapcott	4.3	0.82	176	39	0.29	154	6.0	755	100	9.4	0.244	79	6.3
9	Vacant													
10	J. Wdovic		No sample taken - house vacant											
11	B. Leipala	1.3	0.40	170	11	0.05	164	5.6	785	70	22.0	0.640	83	11.0
12	W. Ranta	6.7	2.1	56	30	0.65	8	6.2	152	31	0.6	0.049	10	0.2
13	D. Young	45	36	358	38	2.8	620	6.5	2180	78	0.3	0.490	300	7.9
14	H. Sikala	13	60	645	11	15.0	1240	6.0	4100	76	0.1	2.4	520	15.0
15	K.McParland	21	29	590	43	2.7	550	6.1	2110	72	<0.1	0.850	190	3.8

Appendix E

CHEMICAL RESULTS (Continued - 2)

House No.	Name	Colour H.U.	Tur.* F.T.U.	Hard* mg/L	Alk.* mg/L	Iron mg/L	Cl* mg/L	pH	Conduc.* umhos/l	Sulphate mg/L	Nitrate mg/L	Man.* mg/L	Sodium mg/L	Potassium mg/L
16	R. Menard	13	47	670	23	2.5	1080	6.3	3750	59	<0.1	1.51	510	18.0
17	L. Johnson	29	8.4	670	141	0.84	400	7.4	1680	116	<0.1	1.11	77	7.9
18	R. Richard	12	6.2	334	68	0.30	161	6.8	760	50	0.5	0.41	13	4.8
19	F. Dawson	25	8.2	110	31	1.40	25	5.8	342	92	0.6	0.106	23	2.0
20	P.Lehtinen	3.3	0.66	214	43	0.17	120	6.3	655	66	3.3	0.290	37	6.4
21	A. Lehman	1.8	0.53	450	152	1.0	205	6.6	1470	148	39.0	0.660	135	12.0
22	P. Elson	37	20	420	17	3.5	30	5.8	2190	57	0.2	0.430	265	9.7
23	A.Dejmeka	34	30	330	54	4.8	389	6.4	1430	51	0.1	0.295	150	5.2
24	A.Marcini-shyn	6.3	1.7	167	54	0.9	94	6.0	620	67	12.0	0.198	62	4.5
25	Did not want to be surveyed													
26	R. Dawson	24	6.1	294	27	3.0	351	6.3	1310	63	1.5	0.132	135	8.2
27	No answer at door when surveyed													
28	S. Evans	60	0.93	136	33	<0.05	60	6.4	590	60	26.0	0.29	56	11.1
29	J. Labelle	<1	1.6	230	4.6	0.08	146	6.1	875	72	20.0	0.410	78	7.3
30	Vacant													
31	E. Smith	7.2	0.62	208	35	0.06	137	5.8	900	80	29	0.42	89	10.1

CHEMICAL RESULTS (Continued - 3)

House No.	Name	Colour H.U.	Tur.* F.T.U.	Hard* mg/L	Alk* mg/L	Iron mg/L	Cl* mg/L	pH	Conduc* umhos/l	Sulphate mg/L	Nitrate mg/L	Man* mg/L	Sodium mg/L	Potassium mg/L
32	J. Neva	6.3	1.3	220	64	0.21	60	6.4	730	138	20.0	0.750	42	16.1
33	K. Rahnen-fuehrer	7.6	0.62	91	66	0.05	69	6.4	487	65	0.8	0.051	66	4.5
34	E. Ranta	5.6	2.3	296	74	0.30	164	6.6	780	59	0.8	0.016	37	4.4
35	T. Grosart	3.8	1.2	184	81	0.13	82	6.5	870	140	23.0	1.68	99	11.0
36	L. Farrell	<1	1.5	84	33	0.24	19	6.0	233	40	2.6	0.126	12	2.8
37	Vacant													
38	S. Sikala	2.1	1.8	105	11	0.17	73	5.8	352	36	1.0	0.068	20	2.8
39	No answer at door when surveyed													
40	K. Radey	Serviced by communal water												
41	No answer at door when surveyed													
42	P. Kirkbridge	Serviced by communal water												
43	A. Kresam	53	5.3	71	24	1.2	27	6.0	242	50	0.4	0.120	18	1.9
44	D. Crowder	Serviced by communal water												
45	B. Patchett	50	42	266	42	8.6	213	6.0	885	65	<0.1	0.560	66	5.7
46	Did not want to be surveyed.													

* Tur. - Turbidity
* Hard.- Hardness
* Alk. - Alkalinity
* Cl - Chloride
* Conduc. - Conductivity
* Man. - Manganese

COST ESTIMATES

Private Wells

Based on the assumption that private service funding will supply money to drill new wells for each property, the following exercise is employed.

Assumption - 43 residences to be served by individual drilled well water supplies.
- Wells to be drilled to 150 feet in an attempt to provide a suitable quality and quantity of water.
- Private Well Drillers cost of $20.00 per foot for each drilled well.
- Pumps at $500.00 each - 3/4 HP to supply water from 140 feet depth.

Therefore - 43(150 x $20) + 43($500) = $150,500.

NOTE: If this aquifer requires treatment, the cost of water softening equipment ($500.00 each) must also be taken into consideration; therefore - 150,500 + 43(500) = $172,000.

This estimate may or may not be realistic due to unknown and known factors. These are:

1) Will the proposed aquifer of 150 feet prove to be suitable in both quality and quantity aspects to all residences.

2) With the utilization of private drilled well water supplies, no consideration is given for fire protection.

Communal Water Supply

Based on the assumption that the study area is to be serviced by a communal water supply, two alternatives arise. It should be noted that both alternatives will guarantee an acceptable quality and quantity of potable water for each residence and will also ensure fire protection for the study area.

Alternative "A"

This possible solution is to extend the existing communal water supply currently servicing 3 residences in area "A" to area "B".

Assumption - 6000 feet of water main to be placed in order to service area "B" and to provide no dead-ends.
- An average cost of $50 per foot of line which includes, drilling, blasting, fill and cost of the pipe.

Therefore - 6600 x 50 = $330,000.

Alternative "B"

This possible solution is to branch off of the existing Inco Vermillion water supply lime at a valve chamber to service area "B". Area "A" has existing servicing available and is not to be considered.

Assumption - 5000 feet of water main to be placed in order to service area "B" and to provide no dead-ends.
- An average cost of $50 per foot of line which includes drilling, blasting, fill and cost of the pipe.

Therefore - 5000 x 50 = $250,000.

GLOSSARY

A. BACTERIOLOGICAL EXAMINATIONS

1. Coliform Bacteria

The direct search for a specific pathogen in water is too uneconomical and slow for routine control purposes. Instead water is examined for an indication of fecal contamination by using specific groups of bacteria as indicators. When these groups are found in the water it is assumed that the water is potentially harmful. The standard group of micro-organisms used as an indicator is the coliform group which includes all aerobic and facultative anaerobic, Gram-negative, nonspore forming, rod-shoped bacteria that ferment lactose with gas formation within 48 hours at 35°C. Organisms of the Escherchia coli strains which are usually of fecal origin, and of the intermediate and Aerobacter aerogenes strains which are usually but not always of soil, vegetable, or other non-fecal origin are included in this group.

1 (a) Total Coliforms

This group comprises species that are commonly associated with fecal matter (human and animal) and normal inhabitants of soil and vegetation. The presence of total coliforms in water may indicate contamination from soil runoff, or, less recent fecal pollution.

1 (b) Fecal Coliforms

These bacteria are mainly species associated with human and animal fecal matter. The presence of fecal coliforms in water indicates a relatively recent and near pollution input.

B. CHEMICAL ANALYSES

1. Alkalinity

Alkalinity is the measure of the power of a solution to neutralize hydrogen ions. It is used to define the buffering capacity (the capacity to resist changes in pH) of water. Alkalinity is expressed in terms of an equivalent amount of calcium carbonate. This does not necessarily imply that there is this much calcium carbonate in the water or that there is any at all. The alkalinity measurement represents the quantity of acid, expressed as calcium carbonate, needed to reduce the pH of a measured portion of sample 4.5. It is caused by the presence of carbonates, bicarbonates, and hydroxides, and to a lesser extent by the presence of borates, silicates, phosphates, and organic substances. Alkalinity is not considered detrimental to human health but it is generally associated with high pH values, hardness and excessive dissolved solids.

2. Colour - Apparent

Apparent colour includes colour due to dissolved solids and suspended matter. Surface water colour is due mostly to the presence of humic acids derived from decomposition of plant material. In groundwaters colour is usually due to the presence of iron and manganese. Most naturally coloured water (usually yellowish-brown) is harmless. The objective for domestic water supplies in Ontario is 5 Hazen Units.

3. Chloride

Chloride concentrations in water supplies may result from contact with natural minerals, industrial and agricultural wastes, or human and animal sewage. Urban runoff often contains high concentrations of chloride in the winter due to the application of road salt. Chlorides are generally not harmful. Allowable concentrations in drinking water are based on palatibility requirements rather than on health considerations. The water quality objective for domestic drinking water supplies in Ontario is 250 mg/L.

4. Conductivity

Conductivity is defined as the reciprocal of a water's electrical resistence (in ohms) between two electrodes one square centimeter in area and one centimeter apart at a standard temperature at 25°C. It is a measure of the ion concentration in water. In natural waters conductivity is mainly due to calcium, magnesium, sodium, potassium, bicarbonate, chloride, sulfate, and nitrate ions. Conductivity can be correlated with dissolved solids content. In Ontario the dissolved solids content is equal to 0.65 $\pm$ 0.10 times the conductivity. The permitted level for conductivity in drinking water in Ontario is indirectly established by the limit for dissolved solids.

5. Hardness

Hardness, defined as the soap neutralizing power of water, can be expressed in terms of an equivalent concentration of calcium carbonate. Hardness is mainly attributable to the presence of calcium and magnesium ions resulting from the natural accumulation of salts during contact with soil and geological formations. Hardness is objectionable because it reduces the efficiency of soap and it can produce scums and scales. Hardness in drinking water is limited indirectly by the criteria for dissolved solids (maximum of 500 mg/L). Concentrations over 120 mg/L become increasingly inconvenient.

6. Iron

Iron is the most abundant of the heavy metals in nature but despite this abundance it is generally found in relatively low concentrations in natural surface waters. In groundwater, however, conditions may be such that high concentrations of iron remain in solution. Iron concentrations occur in water due to the leaching of soluble iron salts from soil and rocks. Iron is non-toxic even at high concentrations but becomes objectionable in water because of the taste and odour it imparts. It also tends to precipitate as hydroxides staining laundry and porcelain fixtures. Also, ferric iron combines with the tannin in tea to produce a dark violet colour. The water quality objective for drinking water in Ontario (0.3 mg/L) is based on aesthetic and taste considerations.

7. Manganese

Manganese is a common element in nature and found in numerous minerals which include pyrolusite, braunite, manganesespat. It is essential in trace quantities for the proper nutrition of both plants and animals. Although manganese is non-toxic at levels commonly encountered in water supplies, it can cause unpleasant tastes and stain laundry and plumbing fixtures. Iron and manganese are commonly found together.

8. Nitrate Nitrogen

Nitrates are the end products of the aerobic stabilization of organic nitrogen and as such they occur in polluted waters that have undergone self-purification. They can occur in groundwater as a result of leachings from cesspools or fertilized soil. Photosynthetic action is constantly utilizing nitrates and converting them to organic nitrogen in plant cells but in groundwater this action is not possible and high concentrations of nitrates can result. Nitrates are undesirable because their nutritive properties promote the growth of algae and other aquatic plants. Although nitrates are considered non-toxic to adults, high levels in domestic water supplies can lead to a condition known as infant methemoglobinemia in which the oxygen carrying capacity of the blood is inhibited. The maximum acceptable level of nitrates for domestic water supplies in Ontario is 10 mg/L if the water is to be used for infant feeding.

9. pH

The symbol pH is used to designate the logarithm (base 10) of the reciprocal of the hydrogen ion activity. In the case of natural waters the hydrogen ion activity closely approximates the hydrogen ion concentrations in moles per litre. Although the hydrogen ion is a potential pollutant in itself, pH is also intimately related to the concentrations of many other substances. The degree of dissociation of many substances is influenced by pH and since the undissociated compounds are frequently more toxic than the ionic forms pH may be a highly significant factor in determining limiting concentrations. Also the hydrogen ion concentrations is important because it affects the taste and corrosivity of water and the efficiency of chlorination.

10. Sodium

Sodium ranks sixth in the natural order of elemental abundance and is normally the principal ion in brackish or saline groundwater. It is important for all life forms and is generally considered non-toxic. Patients with high blood pressure however are usually warned to avoid the consumption of water containing high concentrations of sodium. Waters softened by the ion-exchange process employed in most domestic water softening equipment, generally contain high levels of sodium.

11. Sulfates

Sulfates occur naturally in water as a result of leachings from minerals. Sulfates may also occur as the final oxidized stage of sulfides, sulfites, and thiosulfates, as the oxidized state of organic matter in the sulfur cycle and as a result of industrial wastes. Water high in sulfates tends to form hard scales on plumbing and increase the corrosiveness of water towards concrete. Under anoxic conditions sulfates serves as an oxygen source for bacteria which convert it to hydrogen sulfide gas. The maximum sulfate concentrations permissible for domestic water supplies in Ontario is 250 mg/L. Although the limit is not based on taste or physiological considerations, concentrations over the limist may exert a cathartic effect on the gastro-intestinal tract.

12. Turbidity

Turbidity is a measure of the optical properties of a water sample. It is attributable to suspended and colloidal matter which diminishes the penetration of light. Turbidity is useful in assessing water clarity. In Ontario turbidity is measured in Formazin Units.

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